Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences

Newfoundland and Labrador Region
Quebec Region

Canadian Science Advisory Secretariat
Science Advisory Report 2009/074

CURRENT STATUS OF NORTHWEST ATLANTIC HARP SEALS, *Pagophilus groenlandicus*

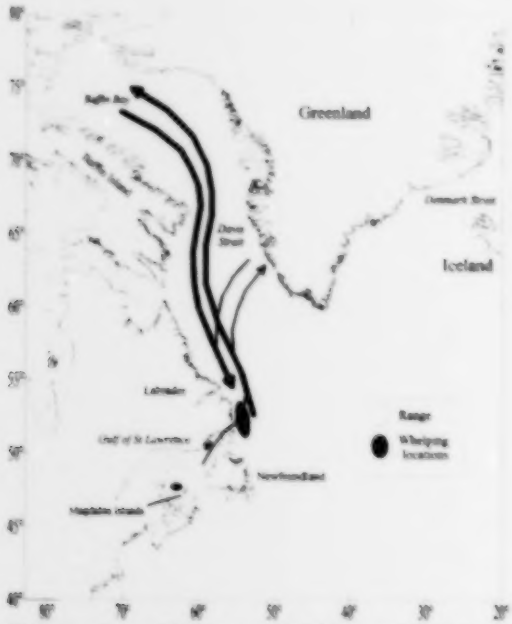

Figure 1: Range, migratory pathways and whelping locations of harp seals in the northwest Atlantic.

Context :

The harp seal is an abundant, medium-sized seal which migrates annually between Arctic and sub-Arctic regions of the north Atlantic. Three populations of harp seals occur: the White Sea/Barents Sea, the Greenland Sea and the Northwest Atlantic. The northwest Atlantic population summers in the eastern Canadian Arctic and Greenland. In the fall, most of these seals migrate southward to Atlantic Canadian waters where they give birth on the pack ice in the Gulf of St. Lawrence ("Gulf") or off northern Newfoundland ("Front") during late February or March. Following moulting in April and May, harp seals disperse and eventually migrate northward. Small numbers of harp seals may remain in southern waters throughout the summer while others remain in the Arctic throughout the year.

Northwest Atlantic harp seals are hunted throughout their range. They are harvested for subsistence purposes by Inuit in Labrador, Arctic Canada and Greenland and a commercial harvest occurs in the Gulf and at the Front. Approximately 85,000 animals are taken during subsistence harvests, mainly in Greenland. Those catches consist primarily of animals one year of age and older. The commercial harvest generally removed over 300,000 seals per year between 2002 and 2006, but has declined to less than 225,000 seals per year in 2007 and 2008 due to difficult ice conditions and weaker markets. Catches further declined in 2008 to 72,000, the lowest since the early 1990s. Over 95% of the commercial harvest consists of young of the year. A little over 10,000 seals are estimated to be removed incidentally during commercial fishing activities.

Canada

Subsistence harvests are currently not regulated while the commercial harvest is regulated by a five-year management plan that will end in 2010.

It is not possible to survey the entire harp seal population, but the number of pups born in a year can be estimated. This information is incorporated in a population model that also integrates information on age-specific reproductive rates and total removals from the population, including animals that have been killed but not recovered. Pup production is estimated periodically (4-5 year intervals) via aerial surveys conducted in the spring, when the seals gathered on the ice to have their pups. The most recent survey of pup production occurred in 2008 and the estimate of total abundance presented here is based upon data on catches, reproductive rates and surveys up to 2008.

Science was requested to explore the impact of proposed catch scenarios on the population dynamics of northwest Atlantic harp seals. The scenarios consisted of commercial Canadian catches of 250,000, 275,000 or 300,000 annually for three years (2010 – 2012).

SUMMARY

- Northwest Atlantic harp seals are harvested in Canadian and Greenland waters. After averaging approximately 52,000 seals per year between 1983 and 1995, reported Canadian catches increased significantly to a range of 240,000 to 366,000 between 1996 and 2006. Catches have been significantly reduced since 2007 with a reported catch of 72,400 in 2009. Greenland catches have increased steadily since the mid 1970's reaching a peak of approximately 100,000 in 2000. Since then they have fluctuated, averaging around 85,000. Catches in the Canadian Arctic remain low (<1,000).

- This assessment relies on pup surveys completed once every four - five years combined with estimates of reproductive rates and removals to determine total abundance using a population model.

- Total removals of harp seals were estimated using reported catches, estimates of bycatch in the Newfoundland lumpfish fishery and estimates of seals killed but not recovered (referred to as 'struck and lost') during harvesting in the different regions. From 1996 to 2004, high catches in Canada and Greenland resulted in average annual removals of 465,500. However total removals have declined to 250,000 in 2009, primarily due to the lower catches in the Canadian commercial hunt.

- Pregnancy rates among 4 year olds are low and without trend while pregnancy rates of 5 and 6 year olds increased during the 1970s, but declined by the mid 1980s. Pregnancy rates of seals 7 years of age and older remained high until the mid 1980s when they declined to their current low levels. The most recent pregnancy rates, which include data from 2002-2007, are lower than those used in 2008 to estimate total population size of Northwest Atlantic harp seals.

- Surveys were carried out in March 2008 to estimate current pup production. A total of 287,000 (SE=27,600 CV 9.6%) pups were born in the Southern Gulf, 176,800 (SE=22,800, CV=12.9%) in the northern Gulf and 23,400 (SE=5,500, CV=23.5%) in a small concentration at the Front. Visual and photographic surveys of the main concentration at the Front yielded significantly different estimates of 589,400 (SE=49,500, CV=8.4%) and 1,161,600 (SE=112,300, CV=9.7%) pups, respectively.

Possible causes for the difference have been examined, but no explanation has been found.

- Using the photographic survey of the large Front concentration resulted in an estimate of total pup production in 2008 of 1,648,800 (SE=118,000, CV=7.2%), whereas using the visual survey resulted in an estimate of 1,076,600 (SE=61,300, CV=5.7%). The lower estimate is consistent with that predicted by the harp seal assessment population model but the higher estimate is not.

- Given the discrepancy between the above estimates of pup production, the population model was fitted to the lower pup production estimate in 2008 resulting in a total population of 6.5 million (95% CI= 5.7 to 7.3 million) in 2008 and 6.9 million (95% CI=6.0 to 7.7 million) seals in 2009. The 2008 number is higher than the population projection from the last assessment due, primarily, to the lower reproductive rates observed in recent years and fitting to the new pup production estimate.

- Changes in the population assessment model resulted in a slightly increased estimate of total population (~4%). However, the new estimate was more precise (i.e. lower variance).

- The three harvest scenarios proposed by Fisheries and Aquaculture Management, including one with annual catches of 300,000 in 2010-2012, will respect the objectives of the harp seals management plan and would not result in the projected population dropping below N_{70} before 2012.

- Uncertainty about the estimate of pup production at the Front in 2008, the variability associated with model parameters, as well as potential changes in natural mortality rates due to environmental conditions add uncertainty to estimates of population size and the effect of harvests on the trajectory of the population. Additional uncertainty is associated with our lack of knowledge about removals in Greenland. Because surveys are only completed once every four - five years and only count pups, changes in natural mortality rates of YOY in intervening years may not be detected during subsequent assessments until 10 to 15 years later. The effects of changes in adult mortality would likely be detected earlier.

INTRODUCTION

The last assessment of harp seals was completed in 2005 and was based upon data on catches, reproductive rates and the results of an aerial survey of harp seal pup production carried out in 2004. Aerial surveys to estimate pup production were carried out in March 2008 and analysis completed in 2009. Updated data on reproductive rates and removals were also available. Using these data, the current status of northwest Atlantic harp seal population was re-assessed. The estimates of total population presented here are based upon a population model that incorporates pup production estimates up to 2008, reproductive data to 2007, updated catch data for the Canadian commercial (2009) and Greenland (2007) hunts and assumed values of ice-related mortality.

Using new estimates of catches, reproductive rates and abundance, it is possible to respond to a request from Fisheries and Aquaculture Management for advice on impact of proposed catch

options for the 2010 harvest season on the population. It has been assumed that levels of by-catch have not changed since the previous assessment, and that recent catches in Greenland and the Canadian Arctic have averaged 85,000 and 1,000 animals per year, respectively. The impacts of different harvest scenarios on the population were examined.

Northwest Atlantic harp seals are managed under the Objective Based Fisheries Management approach. It is considered to be a data-rich population and is managed to maintain an 80 % probability that the population remains above a precautionary reference level (N_{70}) which is defined to be 70 % of the maximum previously estimated population size.

Species Biology

The Northwest Atlantic population of harp seals summers in the Canadian Arctic and Greenland. In the fall most of these seals migrate southward to the Gulf of St. Lawrence ("Gulf"), or to the area off southern Labrador and northern Newfoundland ("Front") where they give birth in late February or March on medium to thick first year pack ice. Male and female harp seals are similar in size with adults averaging 1.6 m in length and 130 kg in weight. Females nurse a single pup for about twelve days, after which they mate and then disperse. The pup, known as a whitecoat, moults its white fur at approximately three weeks of age after which it is referred to as a beater. Older harp seals form large moulting concentrations on the sea ice off northeastern Newfoundland and in the northern Gulf of St. Lawrence moult in April and May. Following the moult, seals disperse and eventually migrate northward. Small numbers of harp seals may remain in southern waters throughout the summer while a portion of the population remains in the Arctic.

The Hunt

Harp seals have been hunted commercially since the early 18th century. Catches off Newfoundland and in the Gulf of St. Lawrence increased significantly after 1820 and peaked at over 740,000 seals in 1832. This harvest was directed towards the oil market and was likely a mixture of pups and sexually mature females. Catches ranged from 200,000 to 600,000 throughout the remainder of the 1800s, averaging 360,000 from 1818 to 1913. During the First World War catches declined to less than 100,000 and averaged about 150,000 from 1919 to 1939. Commercial harvesting almost stopped completely during World War Two, but then increased rapidly reaching 450,000 in 1951 and averaging about 288,000 seals per year from 1952 to 1971 (Fig. 2).

The first Total Allowable Catch (TAC) was set in 1971 at 245,000. It varied until 1982 when it was set at 186,000 where it remained until 1996. From 1972 to 1982, the average annual catch was approximately 165,000 seals. Prior to 1983, the large-vessel take of white-coated pups on the whelping patch accounted for the majority of the harvest. A ban on the importation of whitecoat pelts implemented by the European Economic Community in 1983 severely reduced the market, ending the traditional large-vessel hunt. From 1983 to 1995 catches remained low, averaging ~50,000 per year. The quota was increased in the mid 1990s with an average of 262,000 seals taken annually between 1996 and 2002. From 2003-06, a multiyear quota was set at 975,000 seals (average 325,000 per year) with a maximum of 350,000 in any two years and the remainder in the third. A total of 985,312 animals were taken over the three years of this plan (Table 1). The multiyear quota system was not renewed in 2006, and in that year an annual quota of 335,000 was set. The quota was subsequently reduced in 2007 to 270,000 due to poor ice conditions and to ensure the population was maintained above the Precautionary Reference Level. The

2008 TAC was set at 275,000 and at 280,000 in 2009. Although the quota was exceeded in 2006, catches in 2007 and 2008 were ~80% of the TAC. A significant reduction in effort resulted in a 2009 catch of 72,400 which is 26% of the TAC. Young of the year (YOY) seals that have moulted their whitecoat ('beaters') make up over 95% of the harvest since 2000, and 100 % of the catch in 2009.

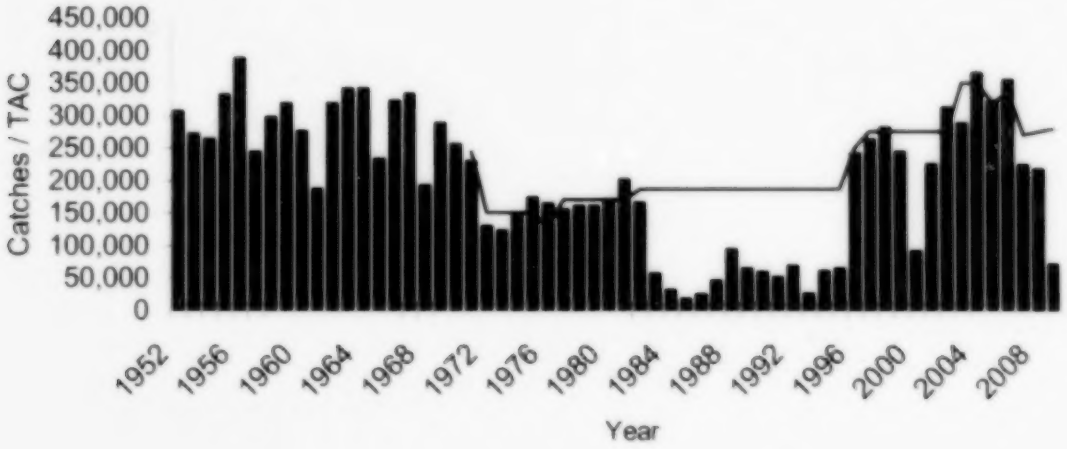

Figure 2. Total Allowable catches (line) and Canadian reported catches (bars) of northwest Atlantic harp seals and quotas, 1952 to 2009.

Harp seals are currently hunted by land-based sealers in both the Gulf and Front areas during the winter. Current regulations do not allow the hunting of adults in the whelping patch, the harvest of whitecoats, or the use of vessels greater than 20 m in length.

Table 1: Canadian commercial (plus TAC) and Greenland catches of harp seals (,000s), 2000-2009.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Canada										
TAC	275	275	275	350[1]	350[1]	319.5	335	270	275	280
Catch	92.1	226.5	312.4	289.5	366.0	323.8	354.9	224.7	217.8	72.4
Greenland										
Catch	98.5	85.4	66.7	66.1	70.6	91.7	92.2	82.8	N/A	N/A

[1] Maximum annual catch under the three year management plan, totalling 975.

Prior to 1980, catches of Northwest Atlantic harp seals in Greenland were consistently less than 20,000 animals (Fig 3). Since 1980, Greenland catches increased relatively steadily to a peak of over 100,000 in 2000. From 2002 through 2004, catches decline to between 66,000 and 70,000 but increased to slightly over 90,000 seals in 2005 and 2007. Slightly over 82,000 harp seals were reported caught in 2007, the last year for which we have data. Seals of all ages are taken in Greenland with the majority being over one year of age.

Catches in the Canadian Arctic are not well documented, but appear to be low with likely fewer than 1,000 harp seals taken annually in recent years (Fig 3).

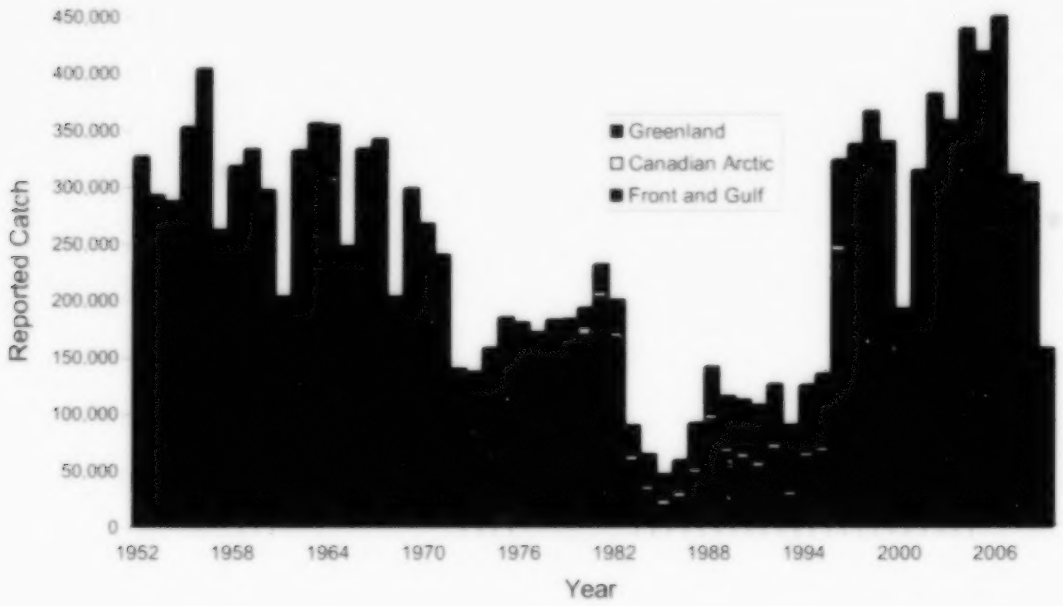

Figure 3: Reported commercial and subsistence catches of harp seals in the northwest Atlantic 1952-2009. Totals do not include seals killed but not landed or those killed as bycatch in commercial fisheries.

Other Sources of Human-Induced Mortality

In addition to reported catches, some seals are killed, but not recovered or reported (referred to as 'struck and lost'). Loss rates of young seals during the large vessel, whitecoat hunt (prior to 1983) are considered to be low (~1%). Estimates of the additional mortality caused by struck and lost for YOY seals which make up the majority of the current harvest in Canada appear to be 5 % (or less) while losses of older seals are higher (assumed to be 50 % of those killed). This higher figure is also applied to catches in the Canadian Arctic and Greenland when estimating total removals (Fig. 4).

Harp seals are also taken as bycatch in fishing gear. The Newfoundland lumpfish fishery is thought to be responsible for the largest bycatch mortality of seals. Seals are taken in other fisheries although the numbers caught have not been estimated. Estimated numbers of seals taken annually as bycatch in the lumpfish fishery were generally below 1,000 seals prior to 1976; however, by the late 1980s and early 1990s catches had increased to over 10,000 in some years (Fig. 4). Peak catch levels occurred from 1992-96 with an average take of 29,431 seals annually. Although catches have been variable in recent years, less than 5,500 seals were taken in 2003. A small number of harp seals (<500/yr) are taken in fishing gear in the northeastern United States.

To estimate the total removals, reported catches in Canada and Greenland are combined with estimates of bycatches and struck and lost. Between 1952 and 1971, removals averaged 388,000 seals, primarily due to commercial catches in southern Canada. Removals fell with the imposition of Canadian quotas in 1971, averaging just over 226,000 from 1972 to1982. The decline of

Canadian catches between 1983 and 1995 resulted in fewer annual removals (average 176,000) although the contribution of struck and lost to the total increased due to the higher level assumed for the Greenland hunt. Between 1996 and 2004, higher catches in Canada and Greenland resulted in average annual removals of 468,500. Since 2007, the level of total removals has declined due to lower catches in the Canadian commercial hunt. Total removals were estimated to be approximately slightly over 250,000 in 2009 (Fig. 4). Young of the year have declined from approximately 65 % of the total removals in recent years to 42 % in 2009.

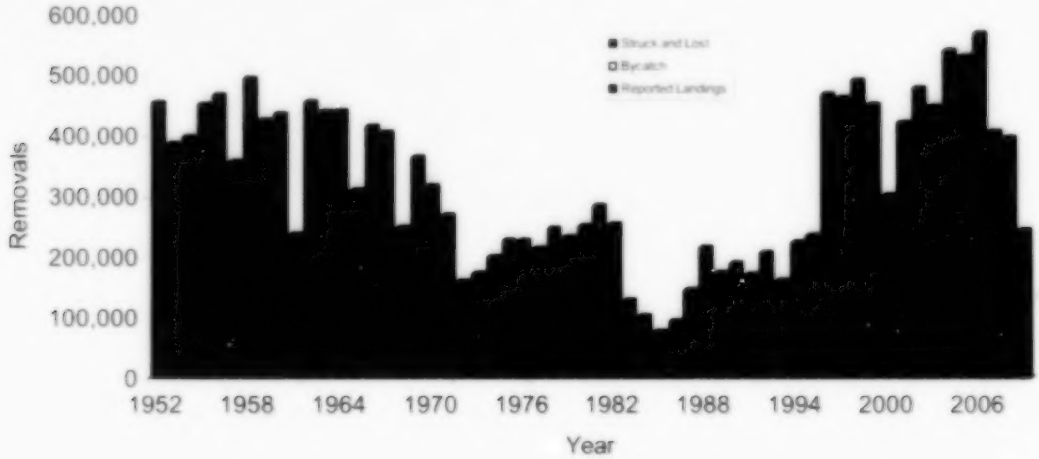

Figure 4. Total removals of Northwest Atlantic harp seals, 1952 to 2009.

ASSESSMENT

Resource Status

The number of harp seal pups born in a year is estimated periodically from aerial surveys conducted in the spring, when the seals gathered to have their pups. Estimates of total population are based on a population model that incorporates these estimates of pup production with information on reproductive rates (the age of sexual maturity and the proportion pregnant each year), catches in Canadian and Greenland, by-catch and struck and lost as well as information on unusual pup mortality due to poor ice conditions.

Pup Production

In the past, pup production has been estimated from catch data, mark-recapture experiments, and aerial surveys. Estimates for the mid to late 1970's ranged from approximately 250,000 to 500,000. The Royal Commission on Seals and Sealing in Canada concluded that pup production in 1978 was about 300,000-350,000 and the total population was about 1.5-1.75 million. Aerial surveys, off the Front and in the Gulf of St. Lawrence, resulted in pup production estimates of 580,000 ± 78,000 pups in 1990, 703,000 ± 125,000 in 1994, 998,000 ± 200,000 in 1999 and 991,400 (± 114,100) in 2004 (Fig. 6). Total pup production increased throughout the 1980s and 1990s (Fig. 6), but appeared to have slowed as the 2004 estimate was not significantly different

from the 1999 estimate. This stabilization of pup production was thought to be due, in part, to the increased catches of young seals since 1996 and was consistent with previous model predictions.

Photographic and visual aerial surveys were carried out off Newfoundland and in the Gulf of St. Lawrence during March 2008 to estimate current pup production. Surveys of five whelping concentrations were conducted between 1 and 16 March resulting in estimated pup production of 287,000 (SE=27,600, CV 9.6 %) in the Southern Gulf and 176,800 (SE=22,800, CV=12.9 %) in the Northern Gulf. A small concentration at the Front was estimated to contain 23,400 (SE=5,500, CV=23.5 %) pups. The visual survey of the main concentration at the Front on 10 March resulted in an estimated pup production of 589,400 (SE=49,500, CV=8.4 %) whereas a photographic survey on 16 March estimated 1,161,600 (SE=112,300, CV=9.7 %) pups.

The reason for the differences between these two Front surveys is unknown although additional photographs are being examined in an attempt to determine which estimate is more likely to be correct. Data collected to determine the temporal distribution of births indicate that virtually all births occurred prior to the first survey and thus, additional pupping cannot account for the difference. Preliminary results indicate that the digital camera system, first used in 2008, provided comparable results to the print film used previously. A second, low coverage, photograph survey at the Front was carried out on 12 March, but not analyzed. Given the length of time required to read the approximately 6,000 photographs taken on the 12th, analyzing this survey was considered to a low priority due to the availability of a survey on the 16th with higher coverage. Once completed, analyzing the photographs from the 12th survey may provide an indication of which estimate, visual or photographic, is more likely.

Using the photographic estimate of the largest Front concentration resulted in an estimate of total pup production in 2008 of 1,648,800 (SE=118,000, CV=7 %); using the visual estimate for the main patch resulted in an estimated pup production of 1,076,600 (SE=61,300, CV=6 %). The lower estimate was consistent with that predicted by the harp seal assessment model while the higher estimate was not.

Reproductive Rates

The reproductive rates of female harp seals are important factors in determining the dynamics of this population. Reproductive tracts of females are examined to determine whether they are mature and if they are pregnant. Pregnancy rates have varied considerably since the 1950s. The percentage of mature females that were pregnant increased from the mid 1950s (85 %) to a peak of 98 % in the mid 1960s. It then declined to approximately 60-70 % during the early 1990s where it has remained. The age at which females become sexually mature has also changed. In the mid 1950s the average age at which harp seals matured was 5.8 years whereas from the late 1970s through the mid 1980s they matured a year younger (~4.5 years of age). By the mid 1990s, the average age of maturity increased to 5.7 years, where it has remained. Although these changes are consistent with a density-dependent response, changes in population size explained relatively little of the variation observed.

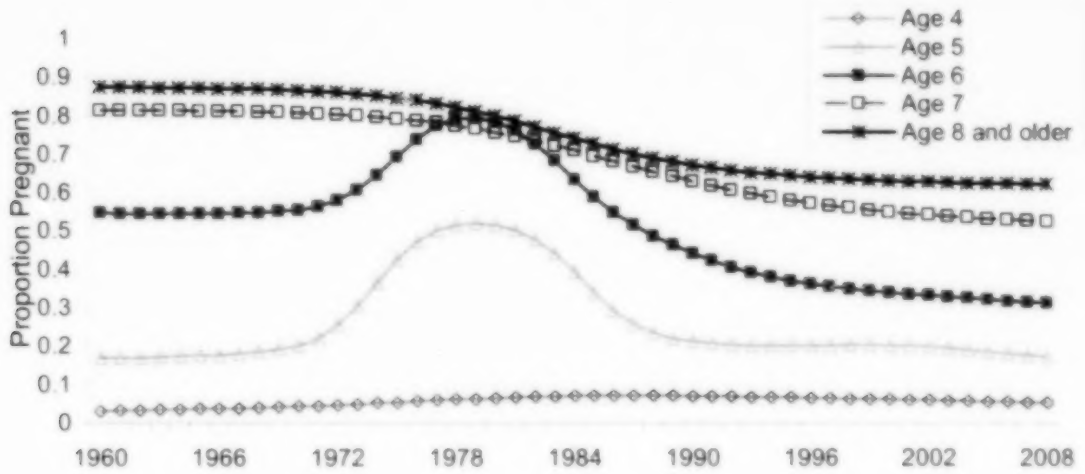

Figure 5. Smoothed estimates of age-specific pregnancy rates of northwest Atlantic harp seals, 1960 to 2008.

Annual age-specific pregnancy rates were estimated by smoothing the raw pregnancy-rate data over the period 1954 – 2008 (Fig 5). Pregnancy rates among 4 year olds remained low (<10 %) throughout the time period. Seals aged 5 and 6 showed a similar pattern; age-specific pregnancy rates initially increased during the 1970s but declined by the mid 1980s to levels similar to, or lower than, those seen in the 1960s. Pregnancy rates of seals 7 years of age and older remained high until the mid 1980s when they declined to their current low levels. Recent estimates are slightly lower than those previously used to estimate total population indicating continued low pregnancy rates for seals 5 years of age and older.

Total Population Size

A model is used to estimate total population size and to examine the impacts of harvests on the population. It is a two parameter model that uses information on age-specific reproductive rates, ice-related mortality of young of the year seals (YOY), and human removals to predict population size. The model is fitted to independent estimates of pup production by adjusting the starting population size and adult mortality to minimize the differences between observed pup production and predictions from the model. Over the past two decades, the same basic population model has been used although over time, this model has been refined in the way that it incorporates reproductive data and to explicitly include more sources of mortality and uncertainty in estimates of total population size.

This year, to improve performance and reduce analysis time, the model was modified to run in a different programming language ('R'). The model was also modified slightly by extending the starting date back to 1952, and changing the resampling process of pregnancy rates to include correlation among age classes within a year. The refined model also no longer uses a fixed age structure for the catches at age. The new formula produced similar population trends to the previous version although it consistently estimated higher populations (~4%) with a slightly smaller variance. This was due primarily to lower, but more precise, estimates of mortality.

The new model formulation was also modified to improve in the manner in which future projections are initiated. Rather than using the estimate of initial population size (i.e. 1952), the future projections are based upon the estimated age structure in 2009.

The model uses data on pup production since the 1952, reproductive rates since 1954, human-induced mortality (catches, by-catch in fishing gear and struck and lost) since 1952 and mortality of young seals due to poor ice conditions since 1969 to estimate pup production and total population size from 1952 to 2009.

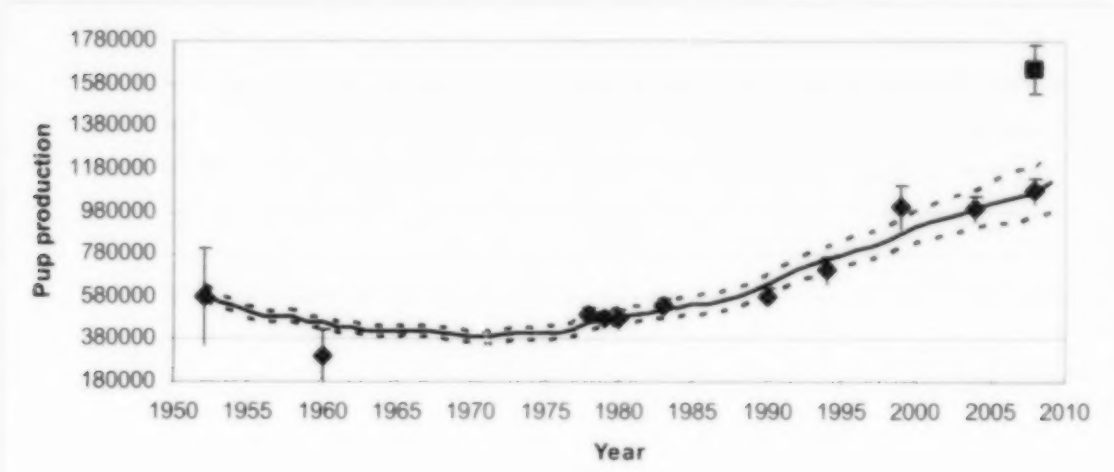

Figure 6: Independent (±1SE) and model (±95% CI, line) estimates of pup production 1952 to 2009, fitted to the low visual estimate of pup production at the Front in 2008.

Given that there are two irreconcilable estimates of pup production at the Front, two separate estimates of current population size were made by fitting the model to pup production series including one, or the other, of the 2008 estimates (Fig 6). Fitting the model to the lower (i.e. using the visual survey at the Front) estimates indicates that abundance declined in the 1950s and 1960s to a minimum in the early 1970s. The population then increased to an estimated 6.5 million (95 % CI=5.7 to 7.3 million) in 2008 and 6.9 million (95% CI=6.0 to 7.7 million) in 2009 (Fig. 7). When the data was fitted to the higher (i.e. using the photographic survey at the Front) 2008 survey estimates, the estimate of total population in 2009 increased to 8.2 million (95 % CI=5.5 to 9.7 million) although the fit to the data was poor.

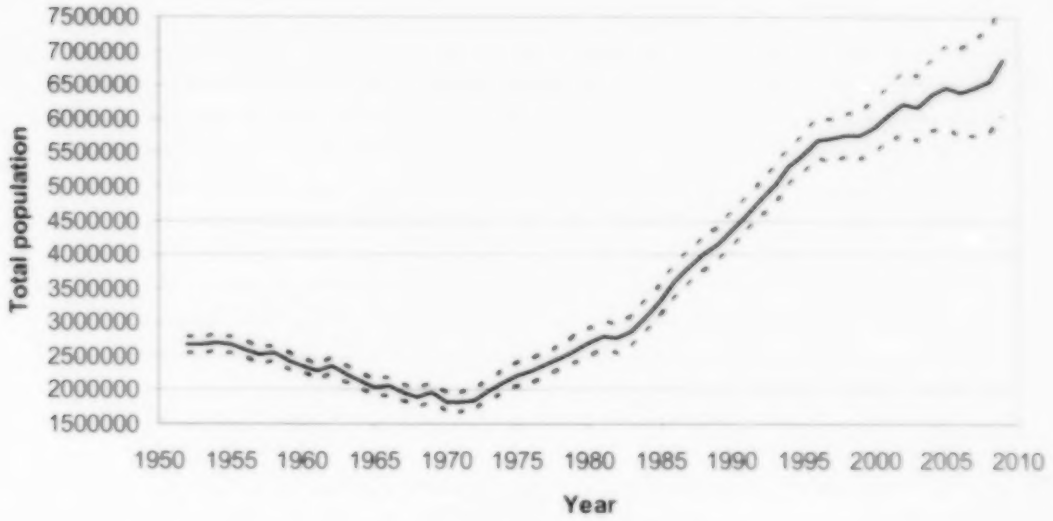

Figure 7: Estimates of total population for Northwest Atlantic harp seals for 1952-2009 (±1SE), using the visual estimate of pup production at the Front in 2008.

Catch options

Fisheries and Aquaculture Management requested that three catch level scenarios, each for three years, be examined within the context of the management plan that ends in 2010 (Table 2).

Table 2: Catch scenarios used to explore the impact of different Canadian catch levels on northwest Atlantic harp seals.

Scenario	2010	2011	2012
A	250,000	250,000	250,000
B	270,000	270,000	270,000
C	300,000	300,000	300,000

Given that the two 2008 pup production estimates at the Front were irreconcilable, the population estimate based upon the lower pup production was used to examine the impact of the proposed quotas. This was considered a conservative approach.

Pregnancy rates, by-catch and removals in Arctic Canada were assumed to be the same as in 2009. As in the past, the Greenland harvest was assumed to vary between 70,000 and 100,000 with an average of 85,000 and the Canadian commercial catch is assumed to consist of 95 % YOY.

All three scenarios met the objective of the current management plan and resulted in a prediction that the population would not fall below N_{70} during this period.

Sources of Uncertainty

Pup production estimates are a critical component of the harp seal population model. The photographic and visual surveys carried out at the Front in 2008 resulted in significantly different estimates of pup production at the Front. The reason for this difference is not known and until it can be reconciled, it is not possible to choose between the two estimates.

Interannual variance in the estimated reproductive rates and mortality due to poor ice has been incorporated into the model projections. However, it is unlikely that all of the uncertainty associated with the abundance estimates is captured. Also, catches are assumed to be without error and the uncertainty associated with estimates of total removals and the ages of catches have not been included. Therefore, the total uncertainty is underestimated.

Removals have been estimated since 1952. However, the accuracy of reported catches, particularly the subsistence catches in the Canadian Arctic and Greenland, is unknown. Also, there is uncertainty about the ages of seals killed in the various catches and the estimates of by-catch in Canadian fisheries. Additional catches likely occur in other fisheries and are assumed to be small, but these have not been quantified.

The Greenland harvest has varied greatly over the last decade and was reported to be 82,000 in the most recent data (2007). This level is equal to, or greater than, the Canadian commercial catch in 2009 (Table 1). The Greenland harvest is not limited by quota; therefore when estimating the impact of future catches, we entered the Greenland harvest into the model as a uniform function with a range of 70,000 to 100,000 for a mean harvest of 85,000 animals. Also, there is considerable uncertainty in the age structure, and level of struck and lost, that occurs in this harvest. Given the level of harvest and the higher proportion of older animals taken, the Greenland harvest has an important impact on the population dynamics of northwest Atlantic harp seals. Also each of the projections were modelled assuming that the level of subsistence catch in the Canadian Arctic, by-catch in fishing gear and the age structure of the harvest remained unchanged. Current estimates of these catches are not available.

The current assessment model estimates natural mortality rates to fit observed data on reproductive rates and total removals to pup production. The model assumes that mortality does not change over the projection period and is constant for seals one year of age and older. However, natural mortality is likely to have changed over the time and with age. Independent estimates of mortality are needed to verify model predictions and to improve information concerning the dynamics of this population.

Climate change may result in reduced availability or thickness of suitable ice in the areas traditionally used by harp seals to give birth and nurse their pups. Also, some climate models predict an increased frequency of storms during the nursing period. These climatic changes may result in increased mortality of pups or changes in whelping locations which can affect our ability to provide accurate predictions of future abundance.

It was necessary to make a number of assumptions about future catches. Extra mortality related to poor ice conditions in 2009 and future years was assumed to follow a uniform distribution with a mean value of 12% but varied equally between 0 and 30 % (0, 0.1, 0.30, 0.20, 0). Also, future Canadian catches were assumed to consist of 95 % YOY. Deviation from these assumptions will affect the reliability of the projections.

CONCLUSIONS

The current assessment model is a modification of the basic approach used since 1980. The new version of the model includes improvements on the manner in which the age structure of catches are estimated and how the reproductive data are incorporated.

Determining the reasons for the difference between the estimates of pup production in the main patch at the Front are important for understanding the status and dynamics of this population. Analysis of the 12 March photographic survey of the main patch and reproductive samples collected in 2008 should provide additional insight into the status of this population.

Fitting the population model to the lower of the two estimates of pup production in 2008 indicates that the population has continued to increase slowly, even though it has been subjected to a high level of removals over the past decade.

The current population estimates are higher than those previously presented, primarily due to the lower reproductive rates observed in recent years. Since the model is fit to the survey estimates of pup production, the number of adults required to produce a given level of pup production is greater than previously estimated.

The impact of three harvest scenarios was estimated using the lower estimate of 2008 pup production. All of the harvest scenarios, including a three year catch of 300,000, would respect the management objectives and would not result in the population dropping below N_{70} before 2013.

The current Canadian catch is directed almost exclusively towards young of the year seals. The high proportion of young in these catches will affect the breeding population and subsequent pup production in future years as these cohorts mature.

OTHER CONSIDERATIONS

Subsistence harvests in Greenland and Arctic Canada are currently not regulated. Harvest levels in these areas, particularly in Greenland, can have a significant impact on the population dynamics of this population.

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ISSN 1919-5079 (Printed)
ISSN 1919-5087 (Online)
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CORRECT CITATION FOR THIS PUBLICATION

DFO. 2010. Current Status of Northwest Atlantic Harp Seals, *Pagophilus groenlandicus*. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/074.